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Comparative evaluation of nutritive value of maize stover treated with chopped and mineralized groundnut and soybean stover

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Abstract

This study assessed the value of upgrading the quality of crop residues. The study involved improvement of quality of maize stover with urea, groundnut powder, soybean powder, mineralized groundnut solution and mineralized soybean solution. The nutritional value of the ground groundnut, ground soybean, mineralized groundnut solution, mineralized soybean solution, and the feeds improved with the ground legume stover and the solutions were assessed for nutritive value using laboratory proximate chemical analysis procedures. The stover were chopped before being mixed with urea, ground stover or the solutions and then offered to animals. Effect of upgrading maize stover with selected legumes was studied for nutritive value by proximate analysis. Five(5) samples of each feeding material were subjected to proximate analysis to determine their nutritive value in terms of crude protein (CP), gross energy (GE), dry matter (DM), ether extract (EE) and nitrogen free extractives (NFE), crude fibre(CF) using the AOAC methods of 2016. Samples were also evaluated for neutral detergent fibre (NDF), acid detergent fibre (ADF), using the Van Soest and Moore Method of 1991 calcium (Ca) using the Atomic Absorption Spectrophotometer (AAS-2016) and direct determination of phosphorus by Atomic Absorption Flame Spectrometry (AAFS-2017).

Keywords: Maize; groundnut; Soybean; Urea; Processing; Stover; Upgrading

1. Introduction

In recent decades, developing countries have increased their share in global dairy production. This growth is mostly the result of an increase in numbers of producing animals rather than a rise in productivity per head. In many developing countries, dairy productivity is constrained by poor-quality feed resources, diseases, limited access to markets and services (e.g., health, credit and training) and dairy animals' low genetic potential for milk production. Unlike developed countries, many developing countries have hot and/or humid climates that are unfavourable for dairying (FAO, 2012) [6].

Dairy industry in Zambia is very small and demand for milk far outweighs supply. The dairy sector in Zambia is a viable industry that could contribute to poverty reduction especially in rural areas. However, over the years this sector has been unable to supply the much needed milk with only an annual supply of about 125 million litres. There is a shortfall of about 25% in the market (Magoye Dairy Farmers Case Study, 2007) [11]. Pandey and Voskuil (2011) [20] pointed out that the recommended annual consumption of milk by the WHO and FAO report is in the range of 200 million litres per year. According to Aregheore (1994) [1], dairy intake of milk in Zambia stands at less than 40 million litres. The

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same report indicated that the dairy industry is not well organized. The dairy herd is estimated at 1 – 2% of total national herd of cattle (i. e 500,000).

Dairy and beef production is relatively small in relation to the large domestic market for beef and dairy products. Aregheore (1994) [1], indicated that in 1982 there were about 600,000 small-scale milk producers (traditional dairy sub-sector) and about 100 large-scale commercial producers (modern dairy sub-sector). The 600,000 small-scale producers provide for on-farm domestic consumption and the estimated production from this sub-sector in 1982 was 28 million litres. The 100 large-scale dairy farms, including 11 state farms were estimated to have produced about 10.5 million litres during the same period (MacDonald and Newton, 2015) [10].

1.1. Seasonal Changes and its Impact on Feed Resources

Feed quality and quantity have been observed to show seasonal fluctuation a trend which affects animal nutrition and performance. Dry seasons in Zambia and many other tropical countries are marked with periods of feed shortages resulting in general retardation in animal growth and production.

It has been observed that milk and beef production by smallholder dairy and beef farmers during the dry season is significantly reduced. During that period, which might last up to six months per year, the quantity of milk, which the average farmer is able to sell and deliver, is reduced by 35%- 60%. Equally, beef animals lose condition. This means that the income of livestock farmers is also reduced considerably during that period. However, it is also observed that in many cases the milk and beef production and the delivery of milk and beef sales by commercial and by progressive smallholder farmers are hardly affected. The milk delivery from about 160 farmers at a Smallholder Dairy Farmers Association (SDFA) is reduced in the period April – October, while the delivery of milk by a commercial farmer is rather consistent during the year (Pandey and Voskuil, 2011) [20].

The benefits of small scale livestock farming include the following aspects: The produced milk is considered as a perfect human food. Through home consumption and sales, it contributes considerably to the health status of the people in rural areas. The sold milk and meat provide the farmer with a regular income throughout the year. Income from milk is more reliable than from beef. Milk sales continue during outbreaks of diseases when livestock movements are banned. The animals provide income through the sale of surplus heifers, and at the same time form a source of meat. Animal protein from beef animals improves nutrition at family and national level. The animals provide organic (kraal) manure, which is essential to maintain good soil fertility at the farm. Small scale farming is agriculture based rural development enterprise, which creates employment in the rural areas. Small scale farming contributes to the formation of a commercial agro-industry and creates business opportunities. Livestock farming requires and therefore develops discipline among farmers and their workers. Milk enhances the immune system of people and in that way contributes considerably to the reduction of child mortality (Pandey and Voskuil, 2011) [20].

Zambia is endowed with vast natural resources such as land, water and fertile soils that support agricultural activities. More than 60% of the population found in rural areas derive its livelihood from agriculture related activities. Fifty (50) percent of rural households earn their income from livestock while forty (40) percent do so from crops. Livestock farmers are more food secure and able to withstand shocks better than their counterparts in crop production. There are over three hundred and ten thousand (310,000) households or 25% of Zambia's farm population that own cattle and its asset value is estimated at over US $1.5 billion (Parliament report, 2013) [21].

Table 1 Nutrient Composition of Common Dry Roughages for Dairy Feedstuffs

Feed	DM (%)	CP (%)	DCP (%)	ME MJ/kg	TDN (%)	CF (%)	Ca (%)	P (%)	Vit A IU/g
Maize Stover	87	5.1	2.7	8.2	54	35.4	0.43	0.08	-
G/nut Hay	93	9.6	5.0	7.3	48	31.9	1.12	0.13	-
G/nut shells	94	4.9	1.2	2.9	19	60.4	0.25	0.06	-
S/bean straw	88	4.8	1.4	5.8	38	41.2	1.39	0.05	-
S/bean hay	93	14.3	9.6	7.4	49	28.1	1.10	0.22	-

Source: Swedish Cooperative Centre, 2005

The relevance of forage production and utilisation in farming systems rests primarily in its applicability and potential to service the need and aspirations of the integrated small-scale livestock farmers. Forage has been and will continue to be an important resource base for feeding dairy and beef animals in the Southeast Asian region. As a matter of fact, smallholder dairy farmers only own small number of animals, and therefore, adoption of any new technology involves a risk factor whether in economic outlay or management. A systematic critical appraisal of the establishment and management methods of improved pasture and fodder species is probably relevant in the promotion for better development and utilisation of the crop by dairy cattle in the small-scale farming systems (Mohd et al, 2013) [15].

1.2. Environmental, Seasonal and Physiological Factors affecting Milk Quality and Quantity

It has long been known that season of the year has major impacts on dairy animal performance measures including growth, reproduction, and lactation. Fat, protein, lactose, non-fat milk solids (NFMS) and total solids (TS) contents were higher among dairy cows milked in winter season than other seasons. Milk composition is influenced by both season and regional location. This is due to changes in temperature and feed availability during different seasons. Development of different feeding systems according to season and region is needed to produce high quality and satiable milk production (Kitaeg et al., 2009) [8].

Pavel and Gavan (2011) [22] observed that milking period affects milk fat, making the fat percentage lower in the morning compared with the evening milking period. Seasonal differences in milk fat, protein and somatic cell count were significant. Epaphras, Karimuribo and Msellem (2011) [4] reported that the critical period, in terms of daily milk production in Tanzania, was from December through February, a period of high ambient temperature and low rainfall. During this period production dropped to as low as 6.1 and 205 litres/day per cow and farm, respectively. However, these workers observed that there was no significant difference between average daily milk production between dry and wet seasons.

Studies by Mellado et al., (2011) [13], showed a significant quadratic relationship between 305-d milk yield and number of lactation [7,607±145 and 9,548±181 kg for first- and ≥6-lactation cows, respectively; mean ± standard error of the mean (SEM)] with the highest production occurring in the fifth lactation. Total milk yields of cows with ≤2 lactations were approximately 4,500 kg less than milk yields of adult cows (the overall average ± standard milk yield was 13,544±5,491 kg per lactation and the average lactation length was 454±154 d). Moreover, 305-d milk production was depressed in cows induced into lactation in spring (8,804±153 kg; mean ± SEM) and summer (8,724±163 kg) than in fall (9,079±151 kg) and winter (9,085±143 kg).

Milk production changes in both dairy cows and buffaloes due to the change in specific biological functions such as increasing body temperature and enzymatic reactions by climate change (Marai and Habeeb, 2010) [12].

Studies by Pavel et al (2011) [22] revealed significant effect of temperature on milk production and milk components. During winter season buffaloes produced higher milk and milk components than in summer season. They reported positive correlations between plasma ALT with each of total milk yield (TMY), daily milk yield (DMY) and FCM.

Work by Essays (2013) [5], revealed that environmental factors affect lactation curve parameters as well as some production characteristics of Tunisian Holstein Friesian cows. The averages of individual lactations according to the calving season showed a seasonal variation of the shape of the lactation curves.

Feeding efficiency of lactating cows is influenced by seasons due to effect on dry matter intake and T4 levels. The stress induced physiological response like respiration rate, pulse rate and rectal temperature can be used as indicators of heat stress in lactating cows (Singh et al., 2014) [23].

Feed quality and quantity have been observed to show seasonal fluctuation a trend which affects animal nutrition and performance. Dry seasons in Zambia and many other tropical countries are marked with periods of feed shortages resulting in general retardation in animal growth and production.

1.3. Dynamics of Milk Marketing (Demand/Supply relationships)

According to Groover (2000) [7], milk price fluctuates with level of production and has been reported to be a function of seasonal changes. The highest price is received during the period October to January. The driving force behind the current interest in grass-based pasture as the primary source of forage is price. Farmers historically receive the lowest milk price for milk sold during the six months following spring pasture flush. Agricultural prices have shown a seasonal price pattern that corresponds to changes in production/harvest (supply) and end-use (demand).

Livestock sector comprise of beef cattle, dairy and poultry among others. It is a key economic sector in Zambia. In 2009 and 2010 respectively, it contributed 6.4% and 7.4% to the Gross Domestic Product. About 45-47% of the rural population in Zambia depend on livestock for their livelihood with 39.2% of their income coming from the sector (Zambia Development Agency, 2015) [17].

The dairy sector in Zambia is a viable industry that could contribute to poverty alleviation especially in our rural areas. However over the years this sector has been unable to supply the much needed milk with only an annual supply of about 125 million litres. There is a shortfall of about 25% in the market. Pandey and Voskuil (2011) [20] pointed out that the recommended annual consumption of milk by the WHO and FAO is 2000 million litres.

Magoye Dairy Farmers (2007) [11], reported that there a number of challenges that the dairy industry in Zambia faces. These include the high cost of feed, poor breeds of dairy cows, lack of appropriate milk production technology to produce large quantities of milk. This calls for intervention from government and well-wishers as many small scale dairy farmers do not have the capacity to find solutions to some of these challenges.

A recent parliamentary report reviews the current state of livestock farming in Zambia. The livestock sector in Zambia is worth over $1.5bn, accounting for around 35% of agriculture' share of national gross domestic product (GDP). The good news is that the sector has experienced stead growth in recent years. Beef and dairy products are growing around 7% and 10% annually respectively (Parliament report, 2013) [21]. However, despite these positive trends the sector continues to face many challenges which are helpfully highlighted. These include inadequate development funding and taxation reform from GRZ; rampant livestock disease outbreak; poor disease control mechanisms; poor supply of breeding stocks; high cost of cheap and long term finance; poor infrastructure such as roads, and a lack of processing facilities in the form of abattoirs and milk collection centres, among others; high energy costs; shortage and high cost of feedstock; absence of input support; inadequate and inappropriate research; poor extension support; poor organisation of marketing services; and high number of levies on livestock and livestock products (Mukanga, 2013) [17].

There's currently no livestock development policy to deal with these challenges. The government is allegedly in the process of developing one. But it's unclear how robust such a policy is likely to be because one of the things that are clear from the report is that GRZ is working with poor statistics. The exact numbers of livestock in the country are not known. Without proper data it is challenging to formulate strategies that address the key problems (Mukanga, 2013) [17].

It has been observed that milk yield among small holder dairy farmers has been erratic over the years. The levels of seasonal fluctuation of milk yield. Drought occurrence in many parts of Africa is not uncommon. Generally, it has led to poverty at both household and national level. This results from reduced livestock performance and high mortality because of increased malnutrition. Consequently smallholder farmers experience perpetual annual loss of income. This has led to increased food insecurity and poverty.

The main constraint in livestock production under the smallholder sector in Zambia is shortage of feed. The volume of milk sells shrink during winter due to poor feed quality and smallholder farmers have no nutrition technology to mitigate the effect of seasonal change on their business. This is particularly the case in the dry season and recurrent drought periods. However, while it is acknowledged that feed is a major problem in livestock production, at the same time there are vast quantities of under- utilized feed resources such as grass during the rainy season, crop residues and leguminous plants. For example, Li et al., (2014) [9], reported that in 1996 there was 2.9 billion kg of maize stover that was produced. According to Aregheore (1994) [1], the maize stover produced annually in Zambia accounts for more than 60% of crop residues produced under the smallholder sector. Other crop residues reported include sorghum stover (78,000 metric tonnes), wheat stover (51,000) metric tonnes) and rice (17,000 metric tonnes).

Dzowelo et al., (1987) [3], reported that little information is available on the extent to which smallholder farmers in Zambia use crop residue in livestock feed. They went further to indicate that it is unlikely that these resources are underutilized. Even when they are utilized, farmers may not be able to incorporate them effectively year round in livestock programs because they lucky suitable storage facilities and technical know-how on treatment, processing methods and on formulating rations. The real problem is that much of this stover goes to waste. Many smallholder farmers do not look at it as animal feed resource that can be improved in terms of quality so that it becomes more valuable to animals. Rather they look at it as a nuisance and simply leave it in the field to rot and later burn it. Similarly, the vast natural grasses in the rangelands are left to dry up thereby losing nutritional value completely.

Further, most smallholder farmers do not grow any fodder crops that can be used for supplementation during the dry season. The consequence of all these is that the animals under smallholder sector do not receive adequate nutrition thereby severely affecting their productivity: daily gains are unacceptably low; fertility level is very low thereby significantly affecting reproduction; immunity becomes affected thereby exposing animals to different types of diseases; the end product (meat) is of very low quality and therefore cannot fetch good prices on the market. With all these problems, the ultimate is that smallholder livestock farmers are faced with high levels of poverty and the problem seems to be perpetual.

Most dairy farmers tend to give more attention to the overall milk yield in their dairy cows and pay less attention to the overall milk components of their dairy herd. However, consumers and dairy product producing companies that buy milk from dairy farms are more interested in milk components than milk yield. Hence, milk of dairy farmers known to produce milk that has high percentage of components such as fat and protein tend to be more profitable in markets than milk with low percentage of these components. Milk quality problems of the overall dairy herd of a farm are more likely affected by nutrition which in turn affects milk composition. Therefore, poor knowledge of the relationship between dairy cow nutrition, feed intake, milk yield and milk components results in production of low quality milk (Tyasi et al., 2015) [24]. It is against this background that a research project was carried out at Golden Valley Livestock Research Centre in Choma District in the Southern province of Zambia and it was designed:

To evaluate nutritive value of maize stover improved with urea feed grade fertilizer and legume stover.

2. Material and methods

2.1. Research Site

The research was conducted in Southern Province of Zambia. The population of Southern Province as captured by central statistics office (CSO) during the 2010 Census of Population and Housing was 158,992 populations. The province lies at an altitude range of 400- 1400 metres above sea level. It has a mean annual temperature ranging from 14°C to 28°C. It receives an annual rainfall of 700mm to 1000mm .The soil type ranges from clay to sandy loam (Ministry of Agriculture, 2013) [14].

2.2. Research Design and Data Collection

Dry maize stover was chopped using a stover chopper (shredder) and treated using the Urea-Ensiling Technique (UET) before being offered to the cows. The standard method of urea treatment used in other developing countries which involves the making of a solution of urea using four(4) kg urea feed grade fertilizer (46%N) into sixty (60) litres of water and mixing this with one hundred(100) kg of stover was used. Pits were dug on raised ground for the purpose of the UET. The stover was chopped into 3-5 cm pieces. These were then mixed with the urea solution using a watering can and buried into the pit. A polythene plastic and compacting were used to ensure an air-tight environment. The stover and straw were ready for feeding in 21 days (the 3 weeks urea incubation period).

The quality of maize stover was improved using mineralised and chopped legume stover [Groundnuts (*Arachis hypogea*) and Soybean (*Glycine max*)]. These feeds constituted test therapies. The feed ingredients (maize and legume stover) were all procured from local farmers. Four rations were prepared on the basis of cereal type, legume type, source of nitrogen and method of processing of legumes as follows:

- Chopped Maize stover + mineralized Groundnut stover solution
- Chopped Maize stover + chopped Groundnut stover
- Chopped Maize stover + mineralized Soybean stover solution
- Chopped Maize stover + chopped Soybean stover

Test diets were formulated such that they were iso – nitrogenous (same CP) and iso – energetic (same GE or ME). To ensure that the diets were iso-nitrogenous and iso-energetic, samples of cereal stover and legume stover were analysed for their GE and nitrogen content respectively before rations were compounded. Quantities of cereal and legumes (maize, groundnut and soybean stover) used were computed by simple proportion to equate the energy and nitrogen content in each feed based on the results of the proximate analysis. This was important for the data to be valid and reliable.

2.3. Feed Processing

2.3.1. Chopping of Stover

Maize, Groundnut and Soybean stover were chopped into small pieces using a tractor PTO driven stover shredder before being used for ration preparation. Farmers were trained to use available tools such as pangas (machetes) to prepare the stover since they cannot access the technology that employs complicated machines to cut the stover into pieces.

2.3.2. Mineralization of Legume Stover

Dry groundnut and soybean stover were tied into bundles each weighing 5 kg. Three (3) bundles of groundnut stover bundles were completely immersed in 100 litres of water in a plastic drum of 210 litre capacity (Plates 2, 3 and 4). The drum was covered with a tight lid. Another three (3) bundles of soybean stover were treated in a similar manner in another drum. The set up was left for five days to allow for mineralization to take place. A preliminary proximate analysis of samples revealed that a period of five (5) days was the optimum for mineralisation to be effective.

2.4. Ration Formulation

There are several methods for formulating dairy rations. In this research a method called Pearson's Square and Linear Programme with Bounds (BLP88) were used.

Rations were prepared using the BLP 88 computer programme (1987) to meet the nutrient requirements of dairy animals (NRC, 1996) [19]. Amounts generated from the ration formulation programme were measured using a scale and mixed by rolling and turning several times on polythene plastics spread on concrete floor using a garden fork in order to ensure consistence in the composition.

Two types of rations were compounded: one comprising cereal stover and chopped legume stover and the other comprising cereal stover and mineralized legume stover solutions. The mineralised legume stover solutions were sprayed on the measured quantities of chopped maize stover using a watering can and then turned several times using a garden fork on a concrete floor. To help bind the chopped (ground) legume stover to maize stover as well as to improve palatability molasses solution was sprinkled and mixed with all types of rations at compounding. All other ingredients were the same for the rations but only differed in the source of protein and processing method used. Feeds were then packed in 25 kg plastic bags in readiness for delivery to the feeding or milking parlour site where feeding was carried out.

2.5. Proximate Analysis

Five (5) samples of each of chopped maize stover used in studies 1 and 2, chopped groundnut stover, mineralised groundnut stover solution, chopped soybean stover, mineralised soybean stover solution and were analysed for gross energy (GE) using Adiabatic Bomb Calorimeter (ABC) at the food Science and nutrition laboratory at the School of Agriculture of the University of Zambia. The same were subjected to analysis for crude protein (CP), ash, dry matter (DM), ether extract (EE) and nitrogen free extracts (NFE), crude fiber (CF) according to methods of AOAC (2016) [2].

Neutral detergent fiber (NDF) and acid detergent fiber (ADF) were analysed according to methods of Van Soest (1991) [25]. Calcium (Ca) and phosphorus (P) were determined using Atomic Absorption Spectrophotometer (AAS 2016).

This study was a scientific back-up to the practical aspects employed in studies 1 and 2. The information from the laboratory was used to explain any observed differences in the responses of cattle to diets in studies 1 and 2. This process revealed the nutritive value of materials used in the feeding trials. It further assessed and compared the effect of the feeding materials on milk quality.

2.6. Statistical Model

$$Y_{ijk}=\mu + R_i + L_j + P_k + (RL)_{ij} + (RP)_{ik} + (LP)_{jk} + (RLP)_{ijk} + b(x) + \varepsilon_{ijk}$$

Where Y_{ijk} = observed chemical composition on individual ingredient of a given k^{th} processing method, j^{th} nitrogen source and i^{th} ration.

μ = overall mean

R_i = effect of the i^{th} ration

L_j = effect of the j^{th} nitrogen source

P_k=effect of k^{th} processing method

$(RL)_{ij}$=interaction effect of the i^{th} ration and j^{th} nitrogen source
$(RP)_{ik}$=interaction effect of the i^{th} feeding regimen and k^{th} processing method.
$(LP)_{jk}$=interaction effect of the j^{th} nitrogen source and k^{th} processing method.
$(RLP)_{ijk}$=interaction effect of the i^{th} ration, j^{th} nitrogen source and k^{th} processing method.
b(x)=b is the regression coefficient for initial chemical composition used as a covariate
ε_{ijk}=random error component

The concept being promoted was the nutritive value of livestock feeding materials on smallholder farms.

One hundred and forty seven (147) feed samples from the feeding materials used during feeding trials were collected at the time of feed mixing and packed in new transparent plastic bags. The samples were submitted to the Food Sciences laboratory, School of Agricultural Sciences of the University of Zambia for proximate analysis to determine the nutritive value. Each sample had an identity reflecting the feed type written on the plastic bag.

2.7. Statistical Analysis

Data was analysed using the Statistical Analysis System (SAS). Treatment means for major milk components were compared using t-test

3. Results

Table 2 Chemical Composition of Major Ingredients used in Rations

INGRED	DM[a] (%)	CF[b] (%)	CP[c] (%)	Ash[d] (%)	NDF[e] (%)	ADF[f] (%)	NFE[g] (%)	EE[h] (%)	GE[i] (Kcal/kg)	Ca[j] (%)	P[k] (%)
[1]CGNS	97.24	52.93	26.30	1.36	40.64	92.72	14.01	5.40	3970.12	1.45	0.82
[2]MGNS	95.30	43.24	28.53	0.75	44.73	91.60	26.03	1.45	2854.07	0.77	0.44
[3]CSBS	95.95	49.04	21.09	1.15	44.25	93.95	28.51	0.21	4240.23	1.39	1.02
[4]MSBS	92.54	19.34	23.52	0.64	46.13	92.06	55.88	0.62	2830.06	0.93	0.43
[5]UFS	0.00	0.00	45.75	0.00	0.00	0.00	54.18	0.07	1235.22	0.00	0.00
AV.	**76.21**	**32.91**	**29.04**	**0.78**	**35.15**	**74.07**	**35.72**	**1.55**	**3,025.94**	**0.91**	**0.54**
[6]CMS	98.49	78.72	5.00	0.23	51.20	95.84	16.02	0.03	4390.34	2.01	1.77

[1]CGNS =Chopped Groundnut Stover, [2]MGNS=Mineralised Groundnut Stover Solution, [3]CSBS=Chopped Soybean Stover, [4]MSBS=Mineralised Soybean Stover Solution, [5]UFS=Urea Fertilizer Solution, [6]CMS=Chopped Maize Stover [a]Dry Matter, [b]Crude Fiber, [c]Crude Protein, [d]Ash, [e]Neutral Detergent Fiber, [f]Acid Detergent Fiber, [g]Nitrogen Free Extractives, [h]Ether Extract, [i]Gross Energy, [j]Calcium, [k]Phosphorus

Table 3 Mean comparisons for pooled legume ingredients and maize stover

	Av. in untreated MS						**Av. in ingredients**					
	DM[a] (%)	**CF[b] (%)**	**CP[c] (%)**	**GE[I] (%)**	**Ca[j] (%)**	**P[k] (%)**	**DM[a] (%)**	**CF[b] (%)**	**CP[c] (%)**	**GE[I] (Kcal/kg)**	**Ca[j] (%)**	**P[k] (%)**
Mean	98.5	78.7	5.0	4390.34	2.0	1.8	76.2	32.9	29.0	3,025.94	0.9	0.5
Standard deviation	±7.6	±7.4	±0.8	±760.1	±0.1	±0.04	±22.6	±22.6	±9.8	±1187.5	±0.6	±0.4
Sample size	5.0	5.0	5.0	5.0	5.0	5.0	5.00	5.0	5.0	5.0	5.0	5.0
Standard value	89.9	42.4	4.8	3 943	2.9	0.7	91.67	7.3	47.0	4197.0	2.82	2.5
t- calculated	0.1	0.3	-0.8	0.002	9.9	25.1	0.124	0.3	-0.8	0.002	9.9	25.1
t-tabulated	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3

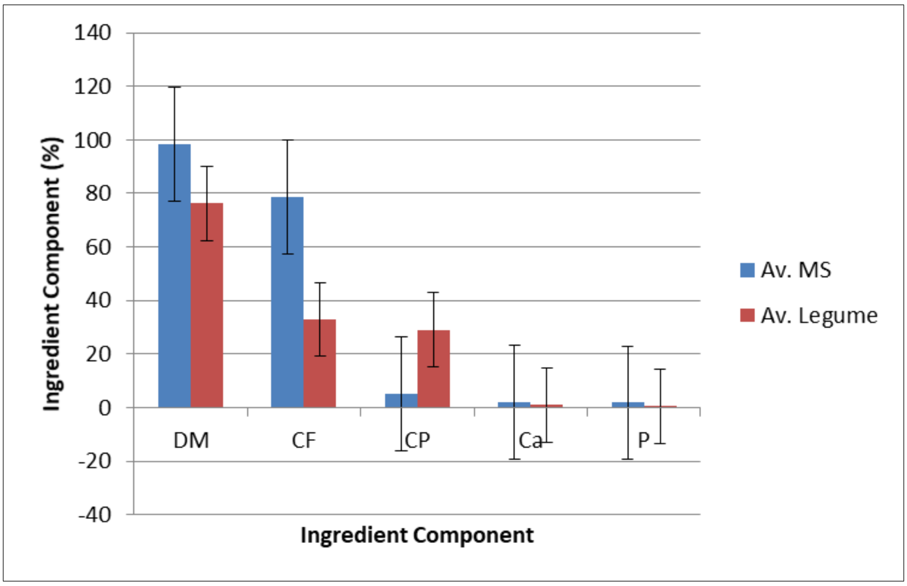

Figure 1 Av. Nutritive Component in Maize and Legume Stover

Table 4 Chemical Composition of Rations

RATION	DM[a] (%)	CF[b] (%)	CP[c] (%)	Ash[d] (%)	NDF[e] (%)	ADF[f] (%)	NFE[g] (%)	EE[h] (%)	GE[i] (Kcal/kg)	Ca[j] (%)	P[k] (%)
[1]MCGNS	94.96	34.25	15.12	1.20	37.48	90.24	47.26	2.17	4360.23	1.59	0.36
[2]MMGNS	94.62	19.75	18.12	1.00	37.46	84.26	59.82	1.31	3992.50	1.21	0.47
[3]MCSBS	94.81	46.25	14.35	1.93	48.22	94.31	35.69	1.78	4390.13	1.02	0.55
[4]MMSBS	95.11	31.28	15.01	0.89	43.78	82.64	52.33	0.49	4366.20	1.55	0.57
[5]UETMS	86.20	27.44	24.61	0.45	38.02	78.30	47.17	0.33	4375.10	0.33	0.06
MEANS	**93.14**	**31.79**	**17.44**	**1.09**	**40.99**	**85.95**	**48.45**	**1.22**	**4296.83**	**1.14**	**0.40**

[1]MCGNS=Maize stover + Chopped Groundnut Stover, [2]MMGNS=Maize stover + Mineralized Groundnut Solution, [3]MCSBS=Maize stover + Chopped Soybean Stover, [4]MMSBS= Maize stover + Mineralized Soybean Solution, [5]UET=Urea Ensilage Treated Maize Stover [a]Dry Matter, [b]Crude Fiber, [c]Crude Protein, [d]Ash, [e]Neutral Detergent Fiber, [f]Acid Detergent Fiber, [g]Nitrogen Free Extractives, [h]Ether Extract, [i]Gross Energy, [j]Calcium, [k]Phosphorus

Table 5 Mean comparisons for pooled rations and maize stover

	Untreated MS						**Treated MS (Rations)**					
	DM[a] (%)	**CF[b] (%)**	**CP[c] (%)**	**GE[i] (%)**	**Ca[j] (%)**	**P[k] (%)**	**DM[a] (%)**	**CF[b] (%)**	**CP[c] (%)**	**GE[i] Kcal/kg)**	**Ca[j] (%)**	**P[k] (%)**
Mean	98.5	78.7	5.0	4390.3	2.0	1.8	93.1	31.8	17.4	4296.8	1.1	0.4
Standard deviation	±7.6	±7.4	±0.8	±760.1	±0.1	±0.04	±3.9	±9.7	±4.3	±170.5	±0.5	±0.2
Sample size	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Standard value	89.9	42.4	4.8	3 943	2.9	0.7	3.0	17.0	16.0	45.8	0.5	0.4
t-calculated	0.2	1.0	-2.1	0.0005	10.4	94.5	0.2	1.0	-2.1	0.0005	10.4	94.5
t-tabulated	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3

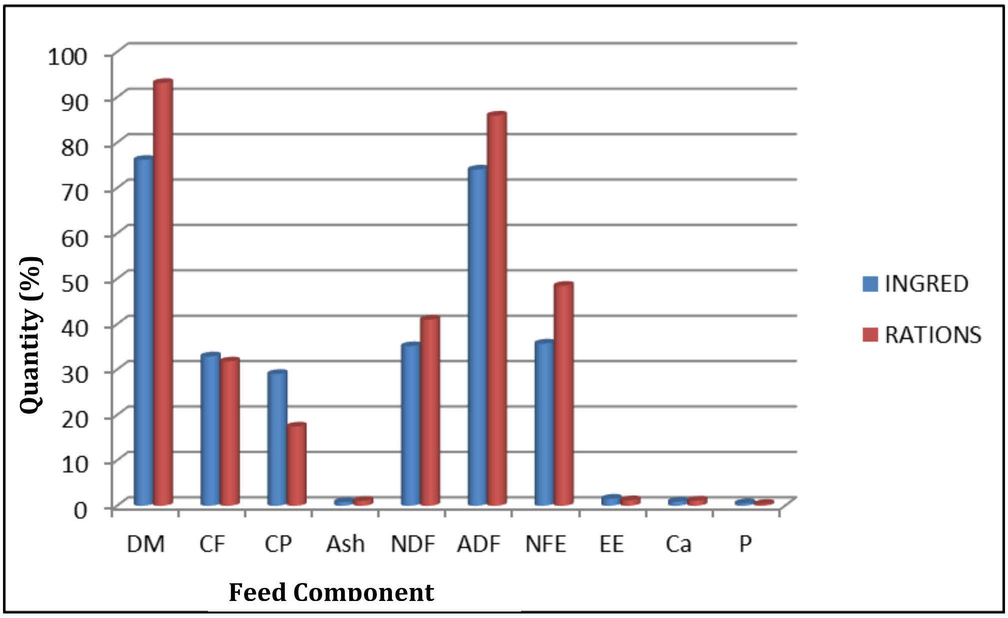

Figure 2 Mean Nutritive value of Ingredients and Rations

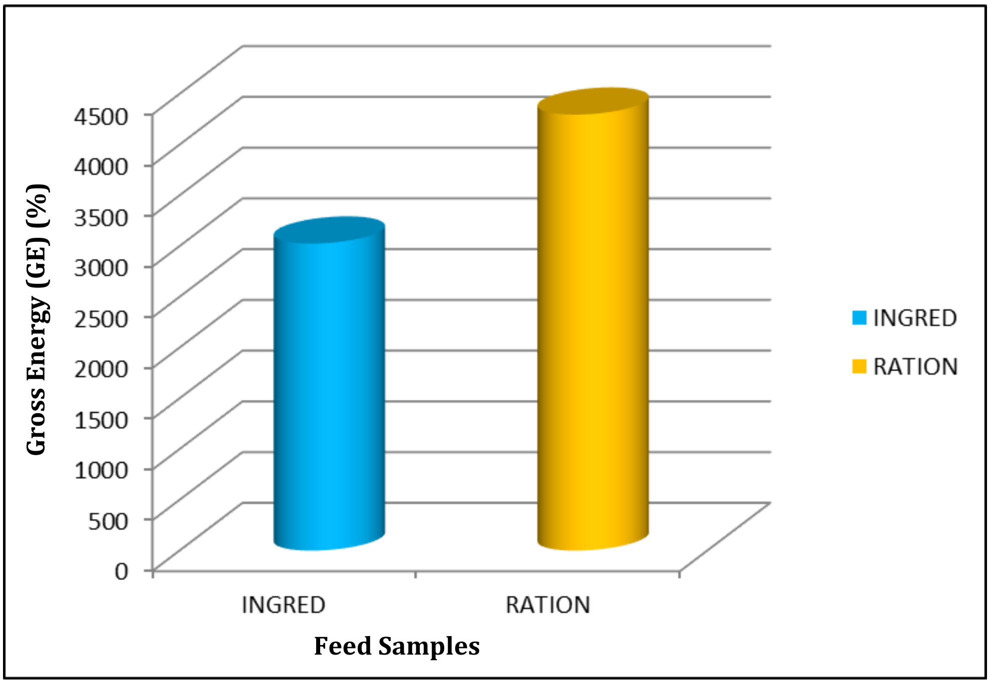

Figure 3 Mean Energy Levels in Ingredients and Rations

4. Discussion

Results of today's study agree with the findings of Mosimanyana and Kiflewahid (2012) [16], who observed the potential for self-sufficiency in feeding dual purpose cattle based on crop residues for milk production. Cereal crop residues are available to all farmers and since they are low in crude protein content, there is a need to supplement them with high protein legumes (cowpeas) and fodder crops (lablab) or locally produced milling by-products (moroko). The feeding systems based on natural grazing (summer) and feeding of conserved crop residues (winter) are the most practical.

Results of this study are in agreement with those reported by Munthali et al (2014) [18], who reported lack of value addition to stover by smallholder farmers. Even when they are utilized, farmers may not be able to incorporate them effectively year round in livestock programs because they lucky suitable storage facilities and technical know-how on treatment, processing methods and on formulating rations.

In a cafeteria type of feeding groundnut stover was found to be more effective in improving the quality of maize stover than soybean stover. The study has further indicated that the potential use of maize stover during the dry season can be improved using through inclusion of legume stover such as groundnut and soybean stover.

For smallholder farmers who cannot afford the use of UET and other expensive inaccessible feeding technologies the use of legume stover offers a cheaper alternative. The stover is available in large quantities as postharvest remains. Unfortunately most smallholder farmers leave them to go to waste through termite attack or worse still burn them when preparing fields for the next season. Results of the current study agree with the conclusion of Wegad and Dumbe (2013) [26], who observed that during the critical period small-scale farmers can prevent loss in live-weight and milk yield by utilizing simple available rations.

Results of the chemical analysis for the feed ingredients (Table 2) and rations (Table 3) show variations in the nutritive value of the ingredients used in the feeding trials. Numerical values ranged from 0.00 to 98.49% for dry matter, 0.00 to 78.72% for crude fiber, 5.0 to 45.75% for crude protein, 0.00 to 1.36% for Ash, 0.00 to 51.20% for neutral detergent fiber, 0.00 to 95.84% for acid detergent fiber, 14.01 to 55.88% for nitrogen free extracts, 0.03 to 5.40% for ether extract, 1235.22 to 4390.34 kcal/kg for gross energy, 0.00 to 2.01% for Calcium and 0.00 to 1.77% for Potassium. Maize stover was observed to be higher in dry matter, fiber and mineral components than legume stover and urea fertilizer. Conversely, maize stover was observed to contain lower levels of crude protein and Ash. When evaluated within the legume type chopped legume stover was higher in DM, CF, Ash, ADF, GE, Ca and P. The reverse was true for CP, NDF and NFE.

Generally energy, DM, ADF, NDF, NFE and EE levels increased in rations than in either pure chopped or mineralised legumes (Tables 2 and 3). Conversely, levels of CF, CP, Ash, Ca and P decreased in the rations than in pure samples (Tables 2 and 3). This can be attributed to dilution factor by introduction of maize stover in the rations.

Proximate analysis of rations showed a generally lower content for most parameters than that found in the analysis of ingredients the only exception being that of Calcium which was observed to be higher in rations than in ingredients.

5. Conclusion

The study has established that effects of drought among smallholder dairy farmers in Southern Zambia can be mitigated by improving the quality of maize stover using legume stover. The study has further indicated that mineralizing legume stover is more beneficial in improving maize stover quality since this method of processing proved superior in maize stover nutritive value than the use chopped legume stover.

Furthermore it is recommended that locally available feedstuffs must be identified and their nutritive value must be determined so as to provide better recommendations to farmers on their efficient use. The study still needs to be deepened by assessing appropriate legume inclusion levels and performances of dairy cows using non-conventional feed resources available on smallholder farms.

Compliance with ethical standards

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Disclosure of conflict of interest

As authors we declare that we have no competing interests. There is no conflict of interest regarding the publication of this article.

Data Availability

Readers can access the data used in the conclusions for this article by contacting the corresponding author through the following contact details: Email: mcmchisowa@yahoo.com.sg or southernuni11@yahoo.com

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